A SMART IMPLEMENTATION FOR GROUND-TO-GROUND COMBAT IDENTIFICATION

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Introduction

In addressing the ground-to-ground combat identification (CI) link, the Product Manager for Combat Identification (PM, CI) is supporting both the near-term Battlefield Combat Identification System (BCIS) and the objective Ground Integrated Target Identification System (GITIS).

To support these efforts, modeling and simulation (M&S) is being used effectively in concept development, hardware development, laboratory testing and characterization, and field testing. With the aid of Simulation and Modeling for Acquisition, Requirements and Training (SMART) tools as an integral part of the iterative design, prototype, and test process, PM, CI plans to demonstrate that the BCIS and the GITIS meet military requirements. It is no longer sufficient that systems meet or exceed technical specifications. They must also improve operational performance and effectiveness. This requires an integrated and iterative design and development process where technical performance, soldier-machine interfaces (SMIs), and operational deployment considerations are addressed concurrently (Figure 1).

BISEPS

To facilitate engineering analyses, design verification, design optimization, and to evaluate "what-if" scenarios, PM, CI developed the Battlefield Identification System Environment Performance Simulation (BISEPS) model. BISEPS is an engineering-level, high-fidelity, non-real-time performance model of the BCIS. As an integral part of the BCIS hardware development, the BISEPS model has been compared against actual field test data and trials with good results in both one-on-one and one-on-many scenarios.

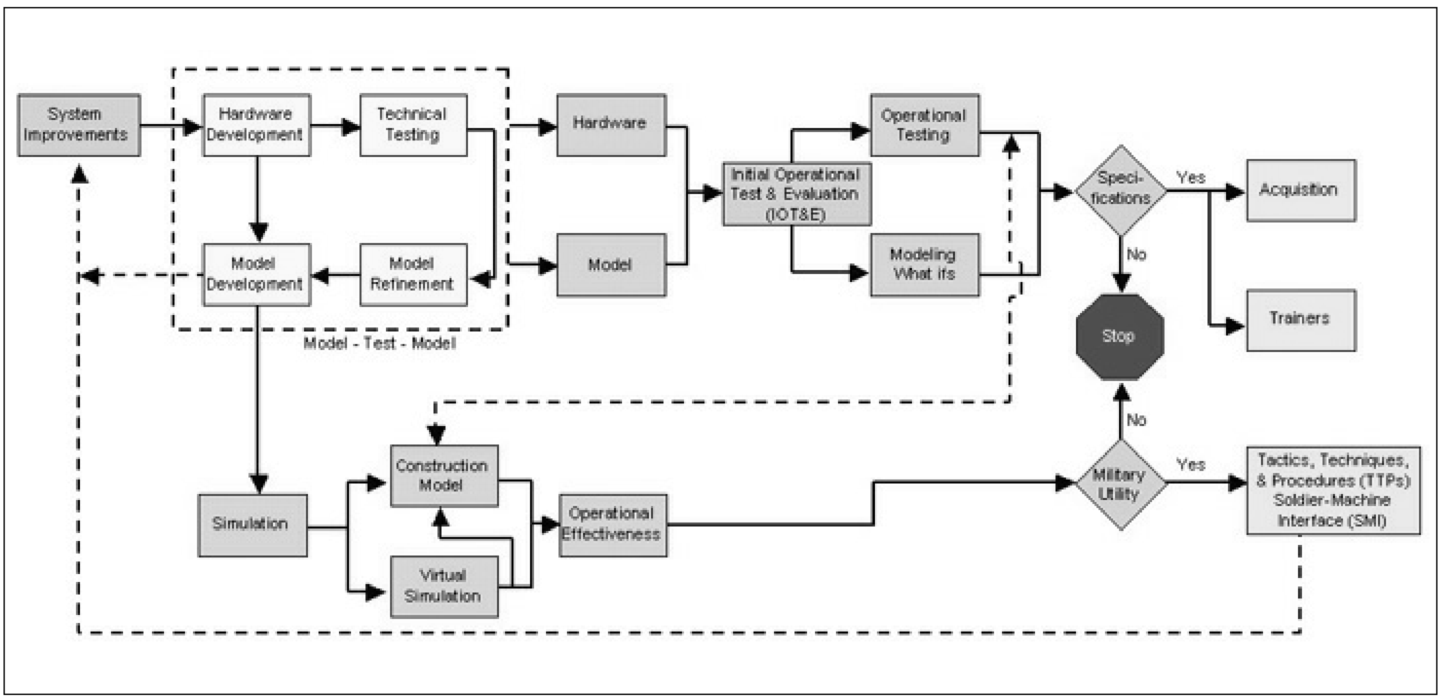

Figure 1.
Iterative concurrent design process

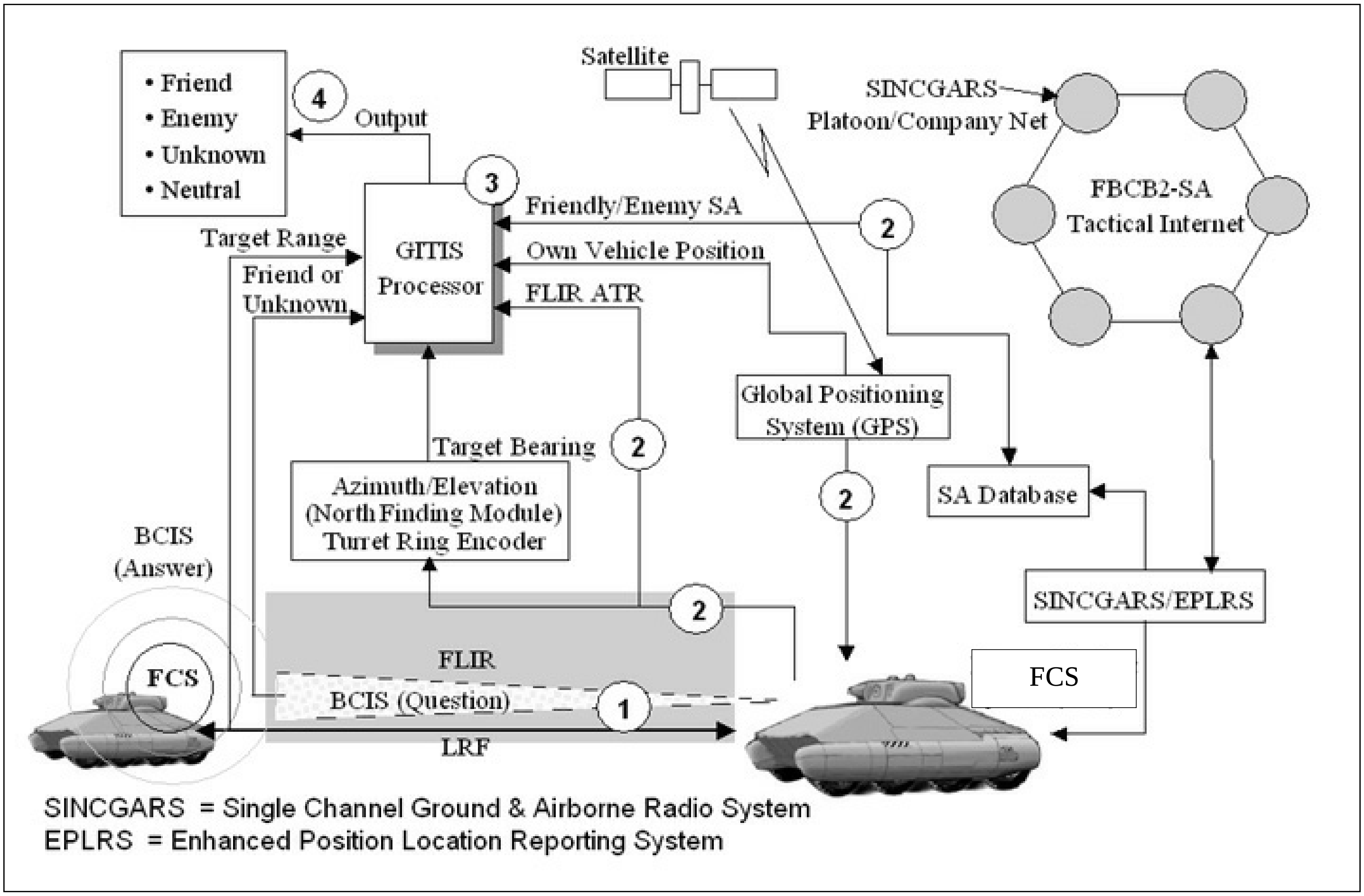

Figure 2.
GITIS concept

To support various distributed simulation exercises using the synthetic environment, BISEPS generated a family of performance contours to accurately and realistically emulate the expected BCIS performance. To facilitate the integration of BCIS within the simulation environment, its performance was evaluated as a function of range, azimuth, elevation, interrogator platform, density of responders, environment, and geometry.

A BCIS simulation module was developed and embedded within the host platform code of each Close Combat Tactical Trainer (CCTT)-manned simulator. Along with this simulation performance module, the BCIS SMI was implemented for both the Abrams M1A1 Main Battle Tank and the Bradley M2 Infantry Fighting Vehicle.

The SMI consists of both visual and audio cues. The visual cue, a red flashing LED (light-emitting diode), is seen in the reticle of the gunners' and commanders' sights. The audio cues, employing a digitized female voice, announce through the vehicle intercom system "friend," "unknown," or "friend at *range*." This friend at *range* response warns the crew that a friendly vehicle is close, although it may not be the targeted vehicle. The *range* is the BCIS computed range.

VIE I

The first Virtual Integration Exercise (VIE I) was conducted in support of the Joint Coalition Combat Identification Advanced Concept Technology Demonstration Program. The M1 and M2 ground vehicle simulators used to support VIE I were modified Simulation Network (SIMNET) simulators located at the Mounted Warfare Test Bed, Fort Knox, KY. Supported by the 3/7 Division Cavalry (DIVCAV) Squadron, this simulation effort involved typical DIVCAV scenarios such as guard, screen, zone, and movement to contact (MTC). Only day missions were conducted because of the limitations of the SIMNET Image Generators. In addition, troop participation was limited because of the short supply of simulators.

The Low-Rate Initial Production Army Systems Acquisition Review Council for the BCIS directed that a follow-on effort be conducted to fill data gaps remaining from VIE I (additional mission scenarios, nighttime operations, and more troops participating). This led to VIE II.

VIE II

The second exercise conducted by PM, CI (VIE II) was a virtual soldier-in-the-loop simulation at the Fort Hood, TX, CCTT Site 1. Through accredited M&S, VIE II quantified the reduction in fratricide by the BCIS above that provided by situational awareness (SA). The accreditation and analysis group consisted of representatives from numerous government and industry organizations. The 1st Cavalry's 1-12 Tank Company and 1-5 Infantry

Company conducted scenarios that included attack, hasty attack, hasty defense, and MTC under simulated daytime and nighttime conditions.

The CCTTs at Site 1 were capable of providing the necessary forward looking infrared (FLIR) imagery to support the nighttime trials. There were sufficient CCTTs to support the two companies. The battle trials were conducted during a 3-week period in September 2000. The VIE II results will assist the U.S. Army in making an acquisition decision regarding the BCIS.

The BCIS simulation modules that were developed and integrated within the CCTT simulators to support the VIE II remain at CCTT Site 1 to support future operational and sustainment training of the first BCIS-equipped units.

GITIS

Within the context of the science and technology objective, PM, CI is refining the ground-to-ground GITIS concept (Figure 2). As part of the development process, PM, CI is developing a soldier-in-the-loop virtual simulator incorporating the GITIS concept. The simulator will be used with other models, tools, and analyses to help refine the GITIS requirements.

The GITIS concept involves the fusion of SA information provided by the Force Battle Command Brigade and Below (FBCB2) System, CI data provided by the BCIS, and data from other sensors. These other sensors include the Commander's Independent Thermal Viewer (CITV) for the M1A2, the compass, the azimuth encoder, and the Laser Rangefinder (LRF).

The simulator, hosted on an M1A2 Abrams Main Battle Tank, includes advanced SMI display concepts that provide the combat crew with an integrated view of the battlespace. The commander's station is equipped with two Advanced Multi-Purpose Displays. Although completely reconfigurable by the commander, the commander's station could be one standard operational configuration consisting of the FBCB2 and the CITV displays.

AISU

The gunner's advanced sight system consists of a single display. The Advanced Integrated Sight Unit (AISU) allows both CI and SA data to be simultaneously displayed to the gunner or commander. When a target has been identified as a friendly vehicle, blue symbology is overlaid onto the target. The symbology chosen is consistent with that presently implemented for the FBCB2 display. This is visible at the left side of the display, where SA data regarding a friendly vehicle are maintained despite its placement behind a hill. When the target has been identified as an enemy, red symbology is used. When targets have been determined to be neutral, gray symbology is used. Finally, when a vehicle is being designated or targeted by the commander, it is overlaid with a yellow circle and an "X." At the bottom of the AISU, LRF information to the most recently targeted vehicle is noted in green text.

Conclusion

The GITIS concept will provide more timely estimates of present platform SA positions by employing innovative tracking algorithms, predictive filters, and correlation schemes to mitigate network latencies resulting from existing bandwidth and message traffic. The objective of the GITIS concept is to improve the quality of the SA data while maintaining the achievable FBCB2 message completion rates or speed of service. The GITIS simulator will also contain an Aided Target Recognition (ATR) algorithm to process the M1A2 CITV FLIR imagery. The GITIS concept can be adapted for various platforms and missions, including variants of Future Combat Systems (FCS) and rotary-wing platforms (e.g., Longbow Apache and Comanche).

With the exception of the advanced displays, the GITIS concept can be implemented predominantly with software modifications. This is predicated on the existence of many of the ancillary sensors and subsystems within the overall concept, including the eventual fielding of both FBCB2 and BCIS. It is anticipated that the AISU will be costly to retrofit to existing vehicles, a factor that will play a significant role in these implementations.

There are no constraints, however, regarding new platforms such as the objective FCS. Therefore, FCS may be ideal for the GITIS technology and advanced displays. A concept that integrates GITIS with a suite of survivability systems is under preliminary investigation. This concept includes a local SA display to designate lines of bearing or angles of arrival of potential threat emitters. Crews may then use these cues or warnings to quickly react (e.g., mask, discharge smoke, or initiate countermeasures) to immediate lethal threats.

To develop and field better systems quickly and at less expense, the PM, CI is successfully employing SMART initiatives within the realm of Simulation Based Acquisition.

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SMART APPLICATIONS FOR THE UH-60M PROGRAM

Eric F. Edwards and Will Nikonchuk

Introduction

The UH-60 BLACK HAWK Recapitalization/Upgrade Program (the UH-60M Program) was established to meet new requirements for increased lift, range, and survivability, and to address the challenges of the aging utility helicopter fleet. The UH-60M is an improved version of the UH-60 BLACK HAWK helicopter (UH-60A and UH-60L models). The U.S. Army's recapitalization/upgrade of the UH-60 platform is designed to ensure that it remains an integral part of a deployable force on tomorrow's digital battlefield.

The Project Management Office for Utility Helicopters (PMO, UH) is successfully implementing the Simulation and Modeling for Acquisition, Requirements and Training (SMART) process in the UH-60M Program. Being a legacy system, the UH-60 BLACK HAWK does not have a history of modeling and simulation (M&S) development to reference, nor does it offer many M&S lessons learned. However, M&S will be incorporated into the UH-60M Program as a method to demonstrate system effectiveness and save costs in the test and evaluation phase. Furthermore, the PMO, UH understands that investing in M&S during the risk-reduction and engineering and manufacturing development (EMD) phases will result in substantial savings for future upgrades to the UH-60 platform.

UH-60M M&S Strategy

During preparation of the Milestone B contract requirements package, the PMO, UH called on employees from the Redstone Technical Test Center (RTTC) and the U.S. Army Aviation and Missile Command's Research, Development and Engineering Center (AMRDEC) to map out an M&S strategy. As a result, the UH-60M Simulation Support Plan (SSP) was developed to define M&S strategy and present a path to implement M&S in the UH-60M Program.

The U.S. Army developed the SMART process in response to a DOD-level directive to adapt Simulation Based Acquisition (SBA) for all future system acquisitions or major system upgrades. SMART expands SBA by not only including M&S in the acquisition phase of the system life cycle, but by also using it in the training and requirements definition phases.

M&S has been used increasingly throughout the design, analysis, and testing of other aircraft and missile systems that are under development. The application of M&S in the UH-60M Program supports this initiative through the effective use of state-of-the-art technology.

The UH-60M Program is in a risk-reduction phase to further define the system's baseline. As such, the government and Sikorksy Aircraft Corp. (SAC) are conducting trade studies to answer programmatic and baseline design issues prior to entering the integration and qualification (I/Q) phase. The I/Q phase replaces EMD in the UH-60M Program. During the risk-reduction phase, the user has many opportunities through the combat developer to provide feedback on baseline configuration changes to the SAC design team and the PMO, UH. Early user demonstrations (EUDs) will support this user/designer interface.

PMO, UH has also encouraged the use of M&S in the UH-60's design and modernization. The PMO, UH believes that EUDs offer an early opportunity to introduce M&S into the UH-60M Program. One benefit of M&S recognized by the PMO is the ability to rapidly prototype components, subsystems, and eventually the UH-60 system.

Incorporating engineering-level modeling and simulation as prototypes prior to bending metal on a production line is not new to industry or the military. Computer-based models developed for engineering analysis may transition to their hardware subsystems as physical mock-ups. Virtual prototypes capable of easy reconfiguration are an example of M&S used in this transition. Reconfigurable prototypes can be tested under simulated conditions. This allows the design team to evaluate their prototypes in virtual environments.

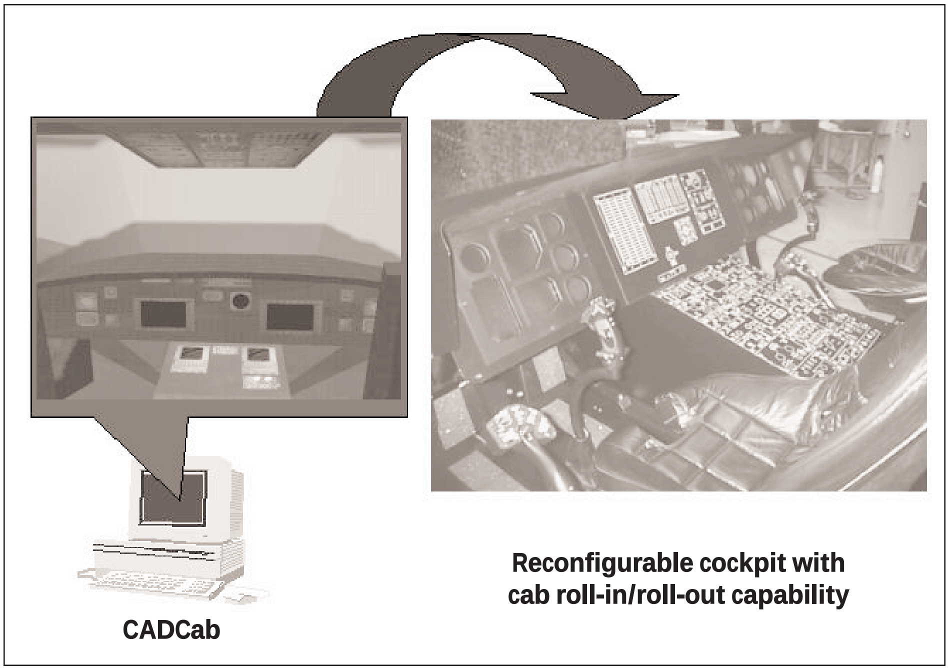
CADCab

UH-60M cockpit design changes are primarily focused on upgrading the controls and displays. PMO, UH will analyze the design changes using virtual prototypes, a reconfigurable cockpit, and a systems integration laboratory. Design changes and the upgrade process are supported by CADCab. CADCab is a Unix-based approach that uses high-end graphics and computer-aided design (CAD) tools to rapidly prototype the proposed UH-60 cockpit configurations within a virtual UH-60 cabin. CADCab provides a 3-D perspective to better assess subsystem spacing. Computer-based prototyping allows for rapid side-by-side analysis of many different configurations. Synthetic imagery allows the design team to properly define control and display requirements and, to a limited degree, assess system-level performance. Better dimensioning leads to a better form and fit analysis for many of the proposed changes to the cockpit and to the associated flight instruments.

Pilot input enhances the form and fit analysis of an instrument panel redesign. Pilot actions can be replicated, demonstrated, and measured when functionality is added to the instruments. A functional capability is possible with this virtual environment because the synthetic instruments are directly coupled with a UH-60 flight model. Current risk-reduction trade studies such as the "4 versus 2" multifunction display (MFD) will benefit from this analysis.

Reconfigurable Cockpit

The reconfigurable cockpit is the pilot's interface with the virtual CADCab instruments. The numerous cockpit configurations developed on the CADCab are ported to the reconfigurable cockpit, which is open-seated with four flat panel displays (FPDs) across the instrument dash panel. Another FPD is



located on the lower console. The FPD's touch-sensitive screen can display virtual MFDs and their associated pages, any number of primary flight instruments and gauges, as well as general-purpose switches. The reconfigurable cockpit has collective, cyclic, and tail-rotor control pedals that are linked to the flight model, allowing the pilot and co-pilot to fly through simulated environments. The cockpit is mounted on lockable casters that allow it to roll in or roll out of a 150 by 45-degree field-of-view dome and projector system. This allows the cockpit to interactively maneuver in any terrain box and with any number of different scenarios displayed onto the projector system.

The CADCab/reconfigurable cockpit approach was developed to address proposed modernization changes to the UH-60 BLACK HAWK during their EUDs. The CADCab/reconfigurable cockpit approach is a low-cost alternative to cockpit hardware changes, hardwiring, or an extensive software development program prior to preliminary design review (PDR). This approach leverages the hardware and software investments made by other programs within the U.S. Army Aviation and Missile Command.

Early User Demonstration

Early user demonstrations consist of three events scheduled throughout the risk reduction and I/Q phases of the UH-60M Program. EUD1 will use CAD and computer-generated imagery to facilitate user and designer communication and analysis during risk reduction and prior to PDR. EUD1 allows pilots (users), designers, and PMO representatives to identify potential user issues and design solutions based on current configurations. EUD1 will also provide an opportunity to define the metrics necessary to measure situational awareness (SA) resulting from information presented to the pilot; establish measures of effectiveness/performance for future SA design and analysis activities; and facilitate initial human factors engineering of candidate instrument panel configurations. EUD1 is expected to provide many lessons learned for EUD2.

EUD2 will capture user feedback on design changes that have been incorporated and approved in preparation for critical design review.

SIL

EUD3 will involve examining hardware and software components on a fully instrumented UH-60M cockpit (aka the System Integration Laboratory (SIL)) located in AMRDEC's Software Engineering Directorate. The SIL contains a fully instrumented UH-60Q cockpit. Once the UH-60M's baseline configuration is defined, the SIL will be integrated with UH-60M upgrade components.

The cockpit will be capable of being stimulated by synthetic environments and simulated control responses. This will allow the user, combat developer, and test and evaluation community to acquire data that will eventually fully support a system analysis and assessment of the digitization and SA capability. During EUD3, the mature SIL cockpit will allow the user to access and interact with the UH-60M cockpit components and will allow user and pilot dialogue, feedback, and evaluation to continue without the delay of obtaining airworthiness and safety releases for the actual aircraft.

Conclusion

PMO, UH is implementing M&S as a design and analysis tool and as a means to communicate user requirements. The SMART approach is being embraced in the UH-60M Program as reflected in the EUDs. As the program progresses, the UH-60M SSP will provide guidance for M&S applications. Other opportunities for M&S applications and future program cost savings are expected.

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